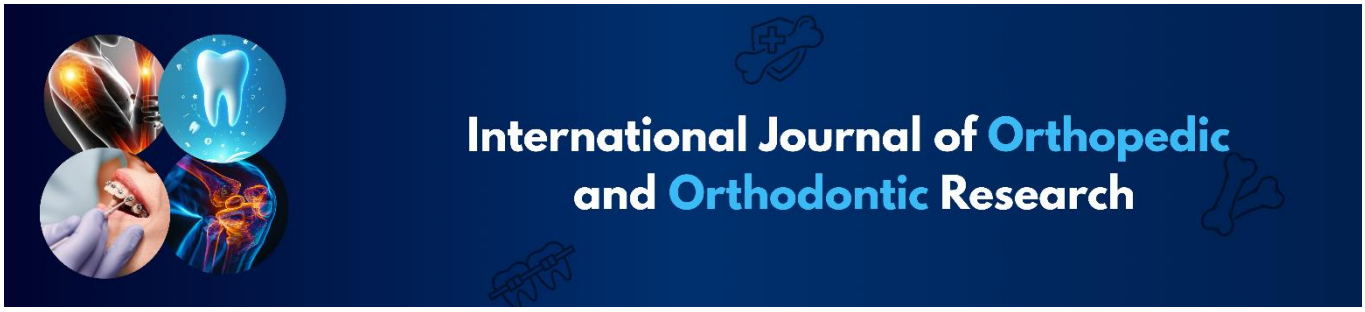

Prophylactic Cusp Rounding of Plunging and Pointed Cusps for Caries Prevention: A Critical Evidence Review and Longitudinal Clinical Research Framework

Dr. Sami Krimly
Prosthodontist, Head of Dental Department, Al-Ahli Hospital, Doha, Qatar

* Corresponding Author: **Dr. Sami Krimly**

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Abstract

Background: The basis for the proposed preventive rounding of plunging or pointed cusps is that the occlusal modification will help to reduce stagnation of plaque, the traumatic contact and resulting caries. This has not been proven clinically. Objective: To assess the recent evidence and consider if a longitudinal clinical study is scientifically and ethically warranted.

Methods: Structured review of English literature published from 2017 to August 2026 in the PubMed database with a focus on caries biology, occlusal and fissure morphology, plaque retention, occlusal adjustment, minimally invasive dentistry and preventive alternatives.

Results: Several clinical studies, such as a 5-year cohort, have shown that deep fissure morphology is associated with increased plaque accumulation and increased caries risk. None of the longitudinal cohorts or RCTs found were appropriate, however, to directly test the hypothesis of rounding of sound pointed or plunging cusps for reduction of caries incidence as a prophylactic measure. Modern occlusal-adjustment studies focus not on caries, but on masticatory function, TMJ disorders or periodontal results. Today, caries recommendations focus on biofilm management, dietary influences, and fluoride application, as well as fissure sealing and retention of remaining tooth structure.

Conclusion: Prophylactic cusp rounding cannot presently be recommended as an evidence-based caries-preventive procedure. In the event of investigation, it has to be clinically equipoise, with minimal irreversible enamel removal, pre-specified safety outcomes, blinded caries assessment, and long-term follow-up against accepted conservative prevention.

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Keywords: Plunging cusp, Pointed cusp, Caries, Decay, Preventive cusp management, Cusp rounding, Occlusion, Traumatic occlusion, Enamel preservation, Caries prevention

Evidence-status note: This manuscript does not fabricate patient-level data. Where the selected topic implies a completed clinical study, the paper is framed as a critical evidence review plus a prospective research framework because no source dataset was supplied.

1. Introduction

Dental caries remains a major global oral health burden despite being preventable, and untreated caries continues to account for a substantial proportion of prevalent oral disease worldwide [1, 2]. Contemporary disease models do not treat caries as a defect caused by tooth shape alone. Instead, lesion initiation and progression reflect dysbiosis within a dental biofilm exposed repeatedly to fermentable carbohydrate, modified by fluoride exposure, saliva, host susceptibility, tooth eruption stage, surface

morphology, and prior disease experience [3-5]. This distinction is important when a preventive intervention proposes irreversible reshaping of intact enamel. A plausible mechanical explanation is not enough; intervention should have incremental clinical benefit compared to non-destructive intervention, and an acceptable harm-benefit balance.

The first topic set provided for this project highlights plunging cusp, pointed cusp, prevention of cusp management, cusp rounding, occlusion, traumatic occlusion, enamel deterioration, and reduces caries or decay rate. These are clinically related, but should not be equated. A deep pit or fissure will provide a protected niche for the ecological community for biofilm to remain, while a pointed cusp may affect contact mechanics or lateral guidance. The best existing anatomic evidence related to occlusal caries is related to the depth and complexity of the fissure, not the sharpness of the cusp-tip. Deep fissures in first permanent molars were linked to an increased risk of incident caries in a 5-year follow-up of schoolchildren [18, 19] and cross-sectional clinical studies have also shown that deep pit-fissure morphology correlated with the amount of plaque and caries experience. Other digital morphology studies have demonstrated an objective measurement of topography, but have not always provided a direct morphology-caries relationship for all samples used [20, 21].

It is therefore necessary to separate three questions in the proposed intervention: prophylactic rounding of a plunging or pointed cusp. First is whether any specific cusp form alone is a risk factor for caries. Second, does selective reduction alter plaque stagnation or cleanability, or does it produce new retentive surfaces, sensitivity, or occlusal disturbance? Third, is there any such intermediate change that can be associated with a reduction in incident carious lesions compared to accepted preventive care? The evidence that deep fissures are caries-prone is not a response to these questions, nor is evidence of occlusal adjustment affecting function. They need evidence from the clinic, looking forward.

This review assesses evidence from the last 10 years reported in the literature and provides a determination of the evidentiary status of prophylactic cusp rounding. The article does not show invented longitudinal outcomes since no patient data set was provided. It rather offers a clinically testable longitudinal research framework and a critical evidence synthesis that could be used for a future registered study.

2. Methods

A structured evidence search for literature was conducted using the PubMed database from January 2017 through 14 August 2026. Search terms used were various combinations of caries, occlusal caries, cusp morphology, pointed cusp, plunging cusp, cusp rounding, selective occlusal reshaping, occlusal adjustment, traumatic occlusion, pit and fissure morphology, plaque retention, sealant, fluoride, minimum intervention dentistry and caries risk. Recent systematic reviews, clinical guidelines, consensus statements, randomized trials, longitudinal studies and mechanistic human studies were preferred. Laboratory or prosthodontic evidence was only used when it helped to clarify mechanical plausibility and was specifically treated as indirect evidence. To meet the pre-specified recency criterion, publications more than 10 years old were not included in the review. It also excluded reports that discussed occlusal adjustment without a clinically relevant outcome, studies of restorative cusp reduction that could not inform intact-tooth prevention, and non-peer-reviewed claims. Evidence was organized by directness to the clinical question: direct clinical evidence for cusp rounding and caries incidence, indirect evidence concerning morphology and plaque/caries risk, indirect evidence concerning occlusal adjustment, and established evidence for alternative caries-preventive strategies. Because the purpose was critical synthesis rather than exhaustive meta-analysis, no pooled effect estimate was calculated.

The primary evidentiary question was whether recent human clinical research demonstrates that prophylactic rounding of sound plunging or pointed cusps reduces incident caries. Secondary questions concerned biological plausibility, foreseeable harms, alternative preventive options, and minimum requirements for a future longitudinal study.

3. Results and Evidence Synthesis

3.1. Caries biology and the role of occlusal morphology

Modern caries management is based on controlling the disease process and maintaining cleanable, remineralizable surfaces wherever possible [6-17]. Biofilm is necessary for the disease process but is not independently deterministic; ecological shifts are driven by environmental exposures, especially frequent fermentable carbohydrates, while fluoride modifies the demineralization-remineralization balance [3,4]. Clinical risk assessment therefore relies on prior caries, active lesions, visible plaque, fluoride exposure, diet, and socioeconomic or behavioral factors rather than tooth geometry alone [17]. A morphology-based preventive procedure should be expected to provide only one component of risk modification and should not be represented as a guarantee of oral hygiene or caries prevention.

Occlusal anatomy does, however, matter. Sánchez-Pérez and colleagues followed schoolchildren for five years and reported that deep fissures were associated with a higher probability of caries development than shallow fissures (OR 3.15; p=0.028) [18]. Kilinc and colleagues found that deep pit-fissure morphology in permanent first molars was associated with both greater plaque accumulation and greater caries experience [19]. Kaskova and colleagues reported that primary molars with more complex occlusal relief were more frequently affected by caries [22]. Three-dimensional plaque mapping further suggests that plaque accumulation is related to both local and global occlusal morphology, while also showing that fissure depth alone does not fully explain plaque distribution [21].

These findings support risk stratification based on occlusal anatomy, but they do not establish that cusp-tip rounding is the relevant modification. Fissure depth, entrance width, branching pattern, and local relief are anatomically different from a pointed cusp. The 2023 digital-topography study of 384 first molars developed quantitative measures of occlusal relief and fissure geometry but found no significant association between its measured topographic variables and caries presence or severity in that limited retrospective sample [20]. This null result is important because it cautions against assuming that every measurable geometric feature is clinically causal.

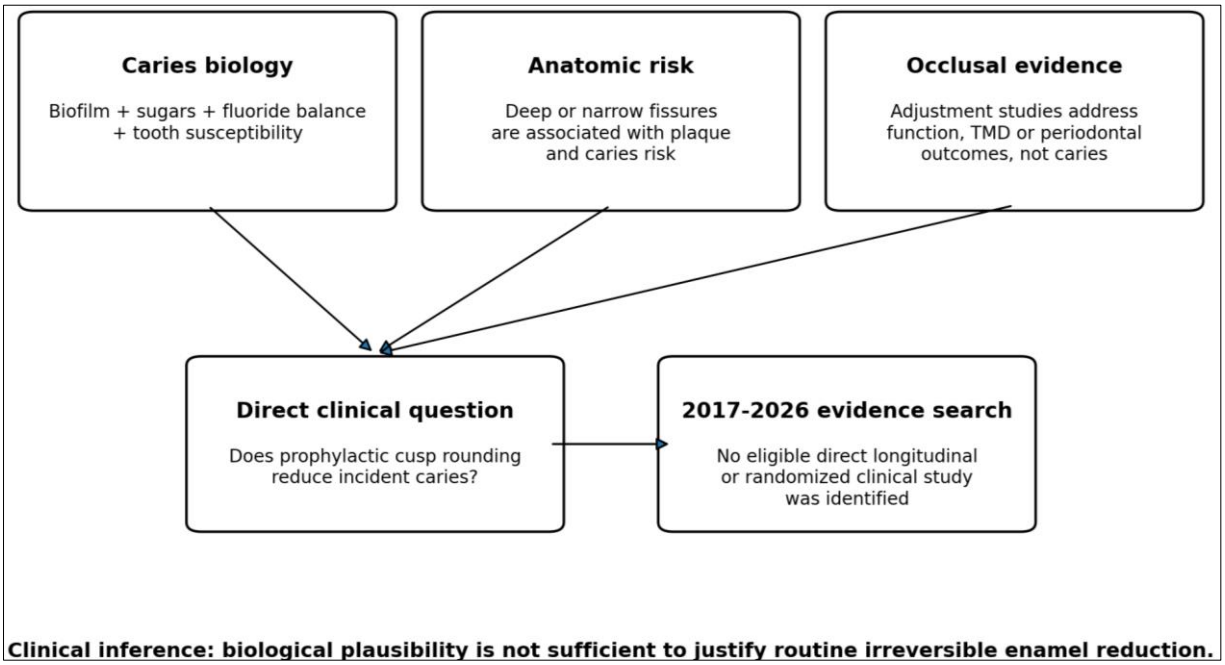

Fig 1: Evidence map for prophylactic cusp rounding. The figure distinguishes direct caries evidence from indirect morphology and occlusal-adjustment evidence. Sources: Sanz *et al*. 2017 [3]; Sanchez-Perez *et al*. 2019; Kilinc *et al*. 2022; Goodacre *et al*. 2020; de Abreu *et al*. 2023.

3.2. What recent occlusal-adjustment evidence actually addresses

Occlusal adjustment is an irreversible procedure that selectively removes tooth structure to alter contacts or guidance. Recent evidence addresses indications such as masticatory function, temporomandibular symptoms, bruxism or periodontal loading rather than caries prevention. A best-evidence consensus statement concluded that the stomatognathic system can adapt to many occlusal changes and emphasized the complexity of linking static occlusal relationships to symptoms [32]. In a double-blind randomized trial in women with sleep bruxism, occlusal equilibration was examined in relation to masticatory muscle activity, not caries incidence [34]. A 2025 meta-analysis evaluated pain outcomes in temporomandibular disorders and described the role of occlusal adjustment as debated [35].

Periodontal literature is similarly cautious. A systematic review of traumatic occlusal forces found limited human evidence of clinically meaningful periodontal benefit from occlusal adjustment [33]. The relevance to preventive cusp rounding is twofold. First, the existence of a functional or periodontal rationale for adjustment does not provide evidence of anticaries benefit. Second, because occlusal alteration can change contact patterns, any caries-prevention trial must measure functional and periodontal safety rather than assume that removing a pointed contact is biologically neutral. Prosthodontic consensus work likewise treats the selection of treatment position and occlusal form as a functionally complex decision [36].

No eligible recent clinical study identified in this search randomized or prospectively followed patients receiving prophylactic rounding of intact pointed or plunging cusps with incident caries as the outcome. Accordingly, the effect size for this intervention is unknown. Its ability to decrease the caries rate should therefore be considered a hypothesis, rather than a clinical fact.

3.3. Biological plausibility: where it is strong and where it becomes speculative

A reasonable sequence of events can be suggested: a sharp or plunging cusp could focus occlusal loading, provide sheltered contour changes, play a role in enamel wear or micro-damage, and indirectly affect plaque stagnation. However, evidence is needed for each link. Protected fissure niches are more directly suggested by the current caries literature than cusp-tip sharpness. Furthermore, enamel is a tissue that cannot be regenerated at the macro level. When sound enamel is removed, to prevent a disease that can often be controlled non-invasively, an immediate and irrevocable cost is incurred. Preserving of sound tissue and delay of restorative cycles are explicit minimum intervention policies and consensus recommendations [6,7,10-16].

The extent of the benefit of rounding also will depend on the amount of tissue that is removed and where. A superficial smoothing which only has the effect of blunting an enamel edge is biologically different from reducing a cusp that provides function or opening a central groove. Over-reduction may reveal additional areas of dentition that are open to permeability, decrease the thickness of the protective enamel, change the occlusal contacts or lead to dentine sensitivity. An intervention may result in a new surface even if there is no acute adverse event, and this will need to be monitored for life. These effects should be taken into account, as the preventive comparator may be highly conservative, namely: individualized hygiene education, fluoride exposure, dietary control and sealing of susceptible fissures if indicated [8,9,23-31].

Also, the idea of traumatic occlusion cannot serve as a proxy for caries etiology. Traumatic occlusal force is a periodontal and functional construct and caries is a multifactorial, sugar-driven, biofilm-mediated, disease. An occlusal contact can be considered clinically indicated for a specific functional reason without being causally related to caries. Risk to

indication shift if these mechanisms are conflated, a procedure supported for one indication is marketed for another without direct testing.

3.4. Evidence-based preventive comparators

Any future study must compare cusp rounding with accepted preventive care rather than with no care. The ADA guideline on nonrestorative caries treatment recommends the use of surface- and lesion-specific fluoride, sealants and other nonrestorative approaches, based on available evidence [8]. The concept of network meta-analysis is in support of the idea that nonrestorative treatments are able to halt or reverse the lesions while reducing sound structure loss [9]. Recent umbrella reviews conclude that pit-and-fissure sealants reduce caries risk in permanent molars compared with non-use, although certainty and comparative rankings vary across materials and reviews [23,24].

Preventive effectiveness is also not one material as seen in clinical trials. Cabral *et al*. compared sealant materials in newly erupted permanent molars [25], Muller-Bolla *et al*. tested fluoride containing and non-fluoride resin sealants in a high-risk population [26] and Elkwatehy and Bukhari compared multiple sealing modalities [27]. Repeated sodium fluoride varnish and one glass-ionomer sealant were found to give a similar dentine-caries result over the trial program, including in the 18-24 month report when the dentine-caries rates were close [28,29]. Systematic evidence is in favor of sealant-versus-varnish comparisons [30] and recent meta-analysis is on caries prevention and retention with different properties of resin-sealants [31].

These data represent an important ethical standard. A new irreversible preventive procedure should not just show a change in shape of the surface. It should demonstrate clinically important benefit in addition to risk-based, non-destructive prevention, while also taking into account harms and patient burden.

3.5. Measurement, classification and causal inference

One of the key challenges to test this topic is the lack of a consistent definition of 'plunging' or 'pointed' cusp in clinical practice. Informal occlusion terminology can be used to refer to steep cusp inclines, a small cusp-tip radius, a cusp that plummets deep into an opposing fossa, or a contact that is deemed heavy during excursion. These features cannot be swapped out. A research protocol that involves an operator's visual judgement of whether a cusp is sufficiently pointed results in classification bias and replication problems. Digital surface acquisition provides a more defendable method as cusp-tip radius, inclination, relief, contact location and adjacent fissure geometry can be captured as continuous data instead of subjective categories [20, 21].

Causal inference is also challenging because morphology is correlated with other risk factors. Newly erupted molars may have deep fissures, incomplete posteruptive maturation, limited brushing access and high plaque at the same time. A child with previous caries is also more likely to receive preventive treatment during follow-up. If cusp morphology is associated with caries in an observational study, confounding by fissure depth, eruption stage, past caries, fluoride exposure and plaque must be addressed before the morphology is treated as a causal target [17-19]. Statistical adjustment does not fully solve this problem if the morphology measure is imprecise or treatment is allocated according to clinician judgment.

The intervention itself should also be decomposed. 'Rounding' may range from finishing a microscopic enamel asperity to reducing a cusp by several tenths of a millimeter. These procedures cannot be pooled as one exposure. A future study should specify the instrument, speed, coolant, direction of reduction, finishing sequence and quantitative stopping rule. Pre- and post-treatment scans should be superimposed to calculate the actual surface and volume removed. This would permit dose-response analysis and would allow an independent safety committee to determine whether deviations in tissue removal are associated with sensitivity or occlusal change.

Finally, prevention research requires attention to competing interventions. If a sealant is placed, high-fluoride toothpaste is provided, and/or a professional varnish or significant dietary advice is given after baseline, the caries outcome cannot be attributed solely to cusp morphology. These co-interventions should be protocolized or recorded prospectively. This is significant since the effect of cusp rounding is not yet known, but the effect of the accepted caries preventive measures have demonstrated clinical effects [23-31].

4. Proposed Longitudinal Clinical Research Framework

The most defensible next step is not routine clinical adoption but a staged research program. A first observation period should be used to determine the exposure precisely. There is a need for reproducible geometric criteria for identifying 'pointed cusp' and 'plunging cusp' other than relying on clinician impression alone, which can be achieved through intraoral scanning or standardized photography. Possible candidate parameters are: cusp-tip radius, cusp inclination, local relief, fissure entrance angle, groove depth and contact position. The result should be incident or progressing caries based on an acceptable system of caries diagnosis (e.g. ICDAS), and if possible, without knowledge of the baseline morphology. This stage would establish if cusp-tip geometry alone is associated with caries after controlling for prior caries, plaque, fluoride, diet, eruption status and fissure depth.

An interventional trial should not be considered unless a reproducible independent association is demonstrated. Participants would have to have morphology that satisfies a pre-specified high-risk definition and sound or non-cavitated target surfaces. The use of irreversible enamel removal and uncertainty of benefit should be specifically considered in the ethical review. Prevention should be modern in a conservative control, in accordance with the level of risk. When cusp rounding is tested, the protocol should specify maximum depth/volume of enamel removal, areas not to be contacted, finishing and polishing requirements, operator calibration and stopping criteria. Digital scans pre and post-treatment would provide an actual measurement of tissue removal.

The primary endpoint should be clinically significant caries (cavitations) that occur on the target surface at least 24-36 months, rather than a short-term surrogate. Secondary outcomes should be plaque at target surface, lesion activity, use of sealants or fluorides after baseline, hypersensitivity, occlusal contact change, new wear facets, cracks, periodontal symptoms and patient-reported discomfort or need for restorative treatment. The repeated scans may be able to measure the unintended geometric change. When more than one tooth is included for a participant, statistical analysis

should include a clustering mechanism and adjust for caries risk at baseline. Attrition and crossover should be reported transparently.

Until there is a definition of baseline event rates and clinically important effect, a sample-size calculation cannot be credible. The five-year fissure cohort is evidence of the ability of morphology to stratify risk [18], but the OR of the deep fissures should not be applied as the expected treatment effect of rounding cusps. This would equate prognostic association with the efficacy of intervention. A pilot feasibility study may be an alternative method to estimating recruitment, operator consistency, retention, adverse events and observed event rates prior to a definitive trial.

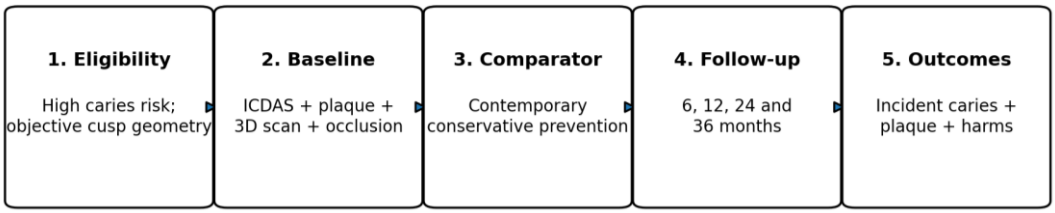

Fig 2: Proposed prospective research framework for testing preventive cusp rounding without implying completed clinical results. Framework informed by contemporary minimum-intervention consensus and caries outcome standards [8-16].

Table 1: Minimum design requirements for a future longitudinal or randomized study.

Domain	Recommended specification	Rationale
Population	Patients with objectively defined high-risk cusp morphology and sound/noncavitated target surfaces	Avoid selection based on visual impression alone
Exposure/intervention	Digitally quantified minimal rounding only if equipoise exists	Record enamel volume removed and occlusal-contact change
Comparator	Guideline-concordant conservative prevention	Do not use absence of care when prevention is indicated
Primary outcome	Incident/progressing ICDAS caries over 24-36 months	Clinically meaningful endpoint
Safety outcomes	Sensitivity, cracks, enamel loss, occlusal symptoms, periodontal changes	Necessary for irreversible preventive intervention
Analysis	Multilevel/GEE models with baseline risk adjustment	Account for multiple teeth per patient and confounding

4.1. Ethics, outcome adjudication and reporting

The moral level for an irreversible preventive procedure should be raised above that of a diagnostic observation. Participants should be told that there is uncertainty about the anti-caries benefit, and that the sound enamel will be changed. It is important to differentiate experimental prophylactic reshaping from clinically indicated occlusal adjustment for pain and/or mobility or for a definite contact problem. In combination, those indications would muddy the waters of efficacy and harm, since the risk-benefit balance for participants with a functional indication is different from those who are asymptomatic and participating in the same trial.

Outcome adjudication should minimize observer bias. Caries examiners should be separate from the clinicians who performed the intervention and should not have access to allocation if visual differences can be masked by standardized digital records. Where the intervention remains visually obvious, a second central assessor can review anonymized photographs or scans. Radiographs should be obtained only when clinically indicated and interpreted using a pre-specified rule. Any restoration placed during follow-up should trigger adjudication of the reason, because restoration placement may reflect caries, fracture, sensitivity, clinician preference, or another event.

Reporting should follow an appropriate observational or randomized-trial guideline and include the protocol, registration number, full intervention description, deviations, withdrawals, harms, and all pre-specified outcomes. Selective reporting is a particular risk when an experimental procedure has several possible surrogate endpoints, such as plaque score, contact force, or surface roughness. A reduction in one surrogate should not be promoted as preventive success if the pre-specified caries endpoint is neutral. Sharing de-identified digital morphology measurements and analysis code would improve reproducibility and allow independent assessment of the geometric thresholds proposed.

5. Discussion

The central finding is a mismatch between the specificity of the proposed intervention and the available evidence. There is strong contemporary support for caries as a biofilm-mediated disease, moderate-to-strong evidence that deep and complex fissures identify susceptible occlusal surfaces, and substantial evidence for sealant- and fluoride-based prevention. In contrast, the structured recent-literature search identified no direct longitudinal or randomized evidence that rounding intact pointed or plunging cusps reduces caries incidence. This evidence gap is not a semantic limitation. It determines what can legitimately be claimed in a scientific manuscript.

A common inferential error would be to move from 'deep or complex occlusal anatomy is associated with caries' to 'simplifying any occlusal anatomy will prevent caries.' Longitudinal and cross-sectional evidence supports the first statement [18,19,22]. The second should be an intervention study as modification can have new biological and mechanical effects. The 3D plaque study also indicates that

the distribution of plaque is determined by the interplay of local and global morphology instead of just one dimension [21]. Therefore, transforming a cusp tip might not actually change the plaque-retentive niche.

The second error would be to utilize occlusal-adjustment literature as indirect evidence. Current occlusal research addresses different questions and yields different results [32-36]. They can provide information for safety monitoring and evidence that occlusal changes are physiologically meaningful, but cannot provide an estimate of anti-caries effect. This is especially relevant for a preventive treatment that is to be used in sound teeth where the acceptable level of damage is minimal.

There are also limitations to the review. There was no systematic review used and the term 'plunging cusp' was not consistent throughout contemporary indexed literature. Relevant work may be indexed by different descriptors due to the use of rare terminology. However, these results, without modern clinical evidence in the multiple contiguous search concepts, and with the support of the current tissue-preserving guidance, the conclusion is conservative. The search should be repeated in at least MEDLINE, Embase, Scopus and Web of Science, with a librarian-developed search strategy, and a reproducible flow diagram, prior to submission to a specific journal.

The clinical significance is thus limited but significant. Cusp rounding might be indicated if there is an independent functional diagnosis, e.g. an obvious traumatic contact in the context of a wider occlusal evaluation. The cusp should not at this time be touted as a standard caries prevention practice just because the cusp looks sharp or plunging. Caries prevention should also be risk-based and preferentially use interventions that preserve sound tissue. The current guidance for caries treatment is also towards conservative carious-tissue removal interventions when operative treatment is indicated [37].

Dentition and eruption stage will also affect external validity. The first permanent molar is especially important, since its occlusal anatomy is exposed at a time when cleaning can be challenging, and when the caries risk can change rapidly. Fully erupted adult molars cannot be assumed to be directly applicable to partially erupted teeth in children, and primary molars have varying enamel thickness, anatomy, and remaining functional life. A future study should either specify a target dentition or pre-specify stratified analyses instead of including biologically different teeth in one treatment effect.

Clinical decision thresholds need to be established in advance of outcomes. If, during the trial, it is decided that only cusp-tip sharpness or contact-force values above a certain threshold can be rounded, then that threshold should be based on reproducibility and pilot data and not optimized after the trial to achieve statistical significance. This also holds true for caries outcomes: activity of the lesion and ICDAS thresholds should be prespecified. Post hoc reclassification would result in a significant risk of selective inference, particularly if the anticipated event rate is small.

The most defensible contribution at the moment is an evidence-gap and research-priority article, not an efficacy report, for journal positioning. A high-impact clinical journal would require actual patient data for a title that has an effect on caries incidence. In the absence of these data, the biological plausibility of this work, absence of direct evidence, safety requirements and a prospective protocols are scientifically sound than simulated numerical results or extrapolation of an effect from unrelated occlusal studies.

The negative evidentiary finding is clinically useful as it prevents premature standardization of a procedure. Dentistry has constantly made progress toward conservation whenever disease control is possible without surgery or with a selective surgical approach [7-16]. To apply that principle here is not to say that the morphology is unimportant, but rather that the morphology must first be proven to provide information beyond what is already known about risk factors and then it must be proven to be a cause that can be modified. This is a sequence that will prevent patients from undergoing irreversible treatment based upon an attractive but untested mechanism.

The proposed framework is also paving the way for falsification. However, if objective cusp sharpness was not found to be predictive of caries, when the effect of fissure geometry and patient-level risk factors were controlled for, the justification for conducting a preventive rounding trial would be significantly reduced. When it is a prediction of caries, but rounding does not lead to a reduction of lesions, the morphology may be a marker and not a cause. Both results will be scientifically interesting, and should be publishable provided the protocol and analysis are sound.

6. Conclusion and Perspectives

Although there is recent evidence that occlusal fissure morphology is one aspect of caries susceptibility, there is no evidence that pointed or plunging cusp form is a modifiable causal risk factor. This review did not find a single eligible 2017-2026 longitudinal clinical study or randomized trial that directly showed an effect of prophylactic cusp rounding on sound teeth on caries incidence. The procedure is thus an unproven preventive hypothesis.

Even if cusp morphology were an objective criterion, it still needs to be validated and established whether it is an independent predictor of disease in a publishable future research program. It is only then that a preregistered, ethically reviewed intervention study should be conducted to compare minimal cusp rounding with accepted conservative prevention, with long-term caries outcomes and explicit mechanical and biological safety endpoints. Preservation of sound enamel, biofilm and diet control, fluoride exposure and evidence-based sealing of susceptible fissures continue to be the defensible standard of prevention until such evidence is available.

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